Graph-based analysis of connectivity in spatially-explicit population models: HexSim and the Connectivity Analysis Toolkit

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Background / Question / Methods

Planning for the recovery of threatened species is increasingly informed by spatially-explicit population models. However, using simulation model results to guide land management decisions can be difficult due to the volume and complexity of model output. This is especially true when simulated movement data is used to evaluate landscape connectivity. To better understand the management significance of simulated dispersal processes, we applied graph-theory-based metrics to transform dispersal data into mapped features that could directly inform planning (for example predicted linkage areas). We focused in particular on two forms of centrality, a group of metrics that consider paths between all possible pairwise combinations of nodes in a graph in order to evaluate the role of each in mediating the flow of dispersers across a landscape. Our study examined both shortest-path betweenness centrality and PageRank (a variant of eigenvector centrality) through the application of these metrics to a graph derived from dispersal events simulated in a HexSim model of the Northern Spotted Owl in the Pacific Northwest.

Results / Conclusions

Shortest-path betweenness centrality identified a network of important linkages, comprising habitat that was frequently used for dispersal. PageRank identified key patches whose importance derived from the observation that dispersers originating from those sites colonized other sites that in turn produced many additional dispersers. We use the insights gained from this analysis to illustrate how a habitat network composed of important linkages and key patches can be used to guide reserve design efforts that seek to conserve population connectivity.